RENEWABLE ENERGIES
WIND AND SOLAR POWER RESOURCE EVALUATION

P. Drobinski, J.C. Dupont, T. Salameh

The atmospheric environment could be a sustainable source of energy for human activity. One of the main challenges for the next century is to develop renewable energy production with a low emission of greenhouse gases. The goal of this course is to get basic knowledge on renewable energy context and issues, on major geophysical concepts in order to quantify wind and solar energy potential of a local or regional area. Independently of the technology and its efficiency what is the available power of a given environment? What is the availability and the variability or the energetic resource? How could we match the variability of the natural energetic resource to the human activity?

This course is divided into 2 parts:

1. Lecture on renewable energies (P. Drobinski)

2. One practical class to be chosen among the two following topics:
   2.a. Wind resource evaluation using in-situ and Doppler lidar wind measurements (J.C. Dupont)
   2.b. Solar resource evaluation using radiative flux measurements and solar panels (T. Salameh)

The two practical classes will use measurements collected at the SIRTA[1] observatory.

A summary will be prepared at the end of the day for the evening presentation and discussion session (day 3).

[1] SIRTA stands for Site Instrumental de Recherche par Télédétection Atmosphérique. It is a French national atmospheric observatory dedicated to cloud and aerosol research. SIRTA is located in Palaiseau (49N, 2E), 20 km south of Paris (France) in a semi-urban environment. The observatory gathers and operates a suite of state-of-the-art active and passive remote sensing instruments from a large community to document and monitor an ensemble of radiative and dynamic processes in the atmosphere. SIRTA is an observatory of Institut Pierre Simon Laplace (IPSL), a French research institute in environmental sciences. It is hosted by Ecole Polytechnique and supported by Institut National des Sciences de l'Univers (INSU/CNRS), Centre National d'Etudes Spatiales (CNES), Centre d'Enseignement et de Recherche en Environnement Atmosphérique (CEREA).

TUTORIAL ON SOLAR RESOURCE EVALUATION

T. Salameh

A. MAIN QUESTIONS TO BE ADRESSED DURING THE TUTORIAL

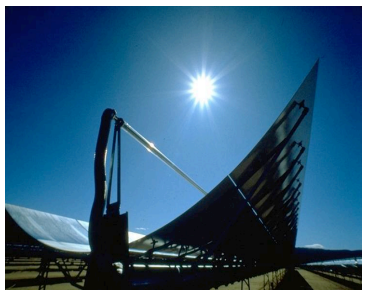
The main issues that will be addressed during the lecture and tutorials are:

1. At one geographical location, how can one evaluate the wind or solar energy?
2. What is the order of magnitude of wind and solar power resource at SIRTA observatory?
3. What are the parameters that can alter the theoretical potential of wind or solar energy production?
4. How can one optimize and manage renewable energy production?
5. Considering your various academic backgrounds, what would you suggest to satisfy the total energy demand with renewable energy in 40 years?

B. CONTEXT AND ISSUES

Sustainable energies are the energies of the future because their sources are endless. Between sustainable energies, we consider in this day study solar energy. Solar energy is based on solar radiation on earth that is theoretically estimated to 1000 W/m2 where the actual expenses of energy are about 100 to 8000 times smaller. Hence it is an important source of energy even though it is not evenly distributed on the spatial and time scales.

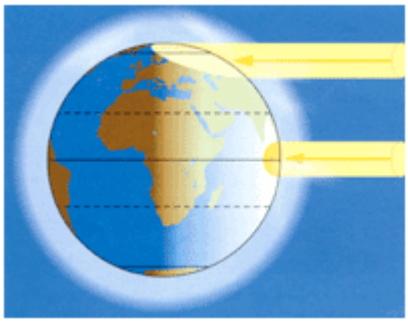
The main two technologies used to produce solar energy are photovoltaic cells and thermal cells. For solar farms, photovoltaic cells are the more used, on arrays or on parabolic troughs with concentrating solar power (CSP).

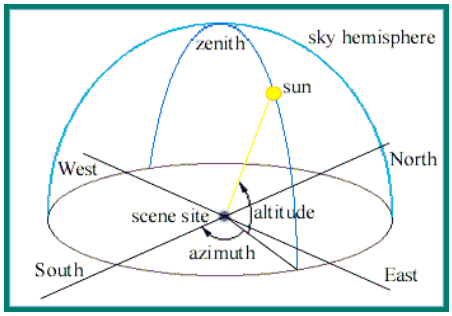


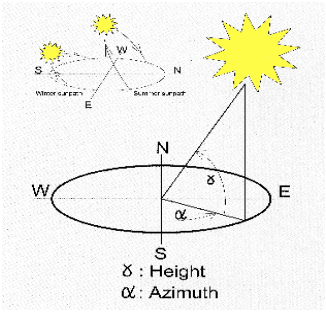
On a given location at the surface of the globe, solar radiation is the sum function of the direct solar flux (Fd) coming from the sun and the reflected one (Fr) coming from the reflection of solar radiation on the surface (albedo) and the particles in the atmosphere (clouds and aerosols). The direct radiation flux depends on the latitude, the season and the hour of the day. Its theoretical approximation is precised. In contrary, the reflected radiation flux depends on local atmospheric variables and terrain characteristics and so its evaluation is more difficult then the evaluation of the direct flux.

C. TUTORIAL OBJECTIVES AND ORGANIZATION

At Ecole Polytechnique, we will use radiative flux measurements collected at SIRTA to characterize solar energy per season and per month. Then we will consider in particular, the impact of the position of photovoltaic arrays and try to evaluate the optimal position following two methods: (1) by conducting statistical studies on the Sirta radiation data and (2) by conducting a sequence of measurements with different positions of the arrays.







At the end of the day, a summary of the characteristics of solar energy on the Ecole Polytechnique is done and suggestions on improving and applying solar production are discussed. In detail, the agenda

Characteristics of solar energy on Ecole Polytechnique site (45 min)

Analysis of the SIRTA radiation data (45 min).

Lunch (1h)

Experiments on the impact of the orientation of solar photovoltaic panels, albedo and reflectors (1h30).

D. SOME REFERENCES

http://www.enseignement.polytechnique.fr/mecanique/Confs/Ferriere_conf.ppt
http://isetinc.com/
http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php
http://www.shodor.org/metweb/index.html